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ROTATIONAL LED REFLECTOR

5 The present invention relates to a light emitting diode (LED) warning signal light having modulated power intensity for use by emergency vehicles and is based upon Provisional U.S. Patent Application No. 60/138,408, filed June 8, 1999, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

10 Light bars or emergency lights of the type used on emergency vehicles such as fire trucks, police cars, and ambulances, utilize warning signal lights to produce a variety of light signals. These light signals involve the use of various colors and patterns. Generally, these warning signal lights consist of incandescent and halogen light sources having reflective back support members and colored filters.

15 Many problems exist with the known methods for producing warning light signals. One particular problem with known light sources is their reliance on mechanical components to revolve or oscillate the lamps to produce the desired light signal. Additionally, these components increase the size of the light bar or emergency lights which may adversely affect the vehicles aerodynamic characteristics. Moreover, there is an increased likelihood that a breakdown of the light bar or light source will
20 occur requiring the repair or replacement of the defective component. Finally, the known light bars and sources require a relatively large amount of electrical current during operation. The demands upon the electrical power system for a vehicle may therefore exceed available electrical resources reducing optimization of performance.

25 The most common light sources being used in light bars or emergency lights include halogen lamps or gaseous discharge xenon lamps. These lamps emanate large amounts of heat which is difficult to dissipate from a sealed light enclosure or emergency light and which may damage the electronic circuitry contained therein. In addition, these lamps consume large amounts of current requiring a large power supply or large battery or electrical source which may be especially problematic for use with a
30 vehicle. These lamps also generate substantial electromagnetic emissions which may interfere with radio communications for a vehicle. Finally, these lamps, which are not

the failure rate, of illumination devices while simultaneously reducing the cost of a replacement illumination source.

In the past, the xenon gaseous discharge lamps have utilized a sealed compartment, usually a gas tube, which may have been filled with a particular gas known to have good illuminating characteristics. One such gas used for this purpose was xenon gas, which provides illumination when it becomes ionized by the appropriate voltage application. Xenon gas discharge lamps are used in the automotive industry to provide high intensity lighting and are used on emergency vehicles to provide a visible emergency signal light.

A xenon gas discharge lamp usually comprises a gas-filled tube which has an anode element at one end and a cathode element at the other end, with both ends of the tube sealed. The anode and cathode elements each have an electrical conductor attached, which passes through the sealed gas end of the lamp exterior. An ionizing trigger wire is typically wound in a helical manner about the exterior of the glass tube, and this wire is connected to a high voltage power source typically on the order of 10-12 kilowatts (kw). The anode and cathode connections are connected to a lower level voltage source which is sufficient to maintain illumination of the lamp once the interior gas has been ionized by the high voltage source. The gas remains ignited until the anode/cathode voltage is removed; and once the gas ionization is stopped, the lamp may be ignited again by reapplying the anode/cathode voltage and reapplying the high voltage to the trigger wire via a voltage pulse.

Xenon gas lamps are frequently made from glass tubes which are formed into semicircular loops to increase the relative light intensity from the lamp while maintaining a relatively small form factor. These lamps generate extremely high heat intensity, and therefore, require positioning of the lamps so as to not cause heat buildup in nearby components. The glass tube of a xenon lamp is usually mounted on a light-based pedestal which is sized to fit into an opening in the light fixture and to hold the heat generating tube surface in a light fixture compartment which is separated from other interior compartment surfaces or components. In a vehicle application, the light and base pedestal are typically sized to fit through an opening in the light fixture which is about 1 inch in diameter. The light fixture component may have a glass or plastic cover made

from colored material so as to produce a colored lighting effect when the lamp is ignited. Xenon gas discharge lamps naturally produce white light, which may be modified to produce a colored light, of lesser intensity, by placing the xenon lamp in a fixture having a colored lens. The glass tube of the xenon lamp may also be painted or otherwise colored to produce a similar result, although the light illumination from the tube tends to dominate the coloring; and the light may actually have a colored tint appearance rather than a solid colored light. The color blue is particularly hard to produce in this manner.

Because a preferred use of xenon lamps is in connection with emergency vehicles, it is particularly important that the lamp be capable of producing intense coloring associated with emergency vehicles, i.e., red, blue, amber, green, and clear.

When xenon lamps are mounted in vehicles, some care must be taken to reduce the corroding effects of water and various chemicals, including road salt, which might contaminate the light fixture. Corrosive effects may destroy the trigger wire and the wire contacts leading to the anode and cathode. Corrosion is enhanced because of the high heat generating characteristics of the lamp which may heat the air inside the lamp fixture when the lamp is in use, and this heated air may condense when the lamp is off resulting in moisture buildup inside the fixture. The buildup of moisture may result in the shorting out of the electrical wires and degrade the performance of the emission wire, sometimes preventing proper ionization of the gas within the xenon gas discharge lamp.

Warning lights, due to the type of light source utilized, may be relatively large in size which in turn may have an adverse affect upon adjacent operational components. In addition, there is an increased likelihood for a breakdown of the light source requiring repair or replacement of components.

Another problem with the known warning signal lights is the use of rotational and/or oscillating mechanisms which are utilized to impart a rotational or oscillating movement to a light source for observation during emergency situations. These mechanical devices are frequently cumbersome and difficult to incorporate and couple onto various locations about a vehicle due to the size of the device. These mechanical devices also frequently require a relatively large power supply to engage and operate the device to impart rotational and/or oscillating movement for a light source. Power consumption of electrical components for an emergency vehicle is of primary

consideration for vehicle operators.

Another problem with the known warning signal lights is the absence of flexibility for the provision of variable intensity for the light sources to increase the number of available distinct and independent visual light effects. In certain situations it may be desirable to provide a variable intensity for a light signal or a modulated intensity for a light signal to provide a unique light effect to facilitate observation by an individual. In addition, the provision of a variable or modulated intensity for a light signal may further enhance the ability to provide a unique desired light effect for observation by an individual.

10 No warning lights are known which are flexible and which utilize a variable light intensity to modify a standard lighting effect. The warning lights as known are generally limited to a flashing light signal. Alternatively, other warning signal lights may provide a sequential illumination of light sources. No warning or utility light signals are known which simultaneously provide for modulated and/or variable power
15 intensity for a known type of light signal to create a unique and desirable type of lighting effect.

No warning signal lights are known which provide an irregular or random light intensity to a warning signal light to provide a desired lighting effect. Also, no warning light signals are known which provide a regular pattern of variable or modulated
20 light intensity for a warning signal light to provide a desired type of lighting effect. Further, no warning light signals are known which combine a desired type of light effect with either irregular variable light intensity or regular modulated light intensity to provide a unique and desired combination lighting effect.

It has also not been known to provide alternative colored LED light
25 sources which may be electrically controlled for the provision of any desired pattern of light signal such as flashing, pulsating, oscillating, modulating, rotational, alternating, strobe, and/or combination light effects. In this regard, a need exists to provide a spatially and electrically efficient LED light source for use on an emergency or utility vehicle which provides the appearance of rotation or other types of light signals without the
30 necessity of a mechanical devices. In addition, a need exists to provide a spatially and electrically efficient LED light source for use on an emergency vehicle which provides a

flashing, modulated, oscillating, rotational, alternating, and/or strobe light effects without the necessity of mechanical devices.

In view of the above, there is a need for a warning signal light that:

- (1) Is capable of producing multiple light signals;
- 5 (2) Produces the appearance of a revolving or oscillating light signal without relying upon mechanical components;
- (3) Generates little heat;
- (4) Uses substantially less electrical current;
- (5) Produces significantly reduced amounts of electromagnetic emissions;
- 10 (6) Is rugged and has a long life cycle;
- (7) Produces a truer light output color without the use of filters;
- (8) Is positionable at a variety of locations about an emergency vehicle; and
- (9) Provides variable power intensity to the light source without adversely affecting the vehicle operator's ability to observe objects while seated within the interior
- 15 of the vehicle.

Other problems associated with the known warning signal lights relate to the restricted positioning on a vehicle due to the size and shape of the light source. In the past, light sources due to the relatively large size of light bars or light sources, were required to be placed on the roof of a vehicle or at a location which did not interfere with, or obstruct, an operator's ability to visualize objects while seated in the interior of the vehicle. Light bars or light sources generally extended perpendicular to the longitudinal axis of a vehicle and were therefore more difficult to observe from the sides by an individual.

The ease of visualization of an emergency vehicle is a primary concern to emergency personnel regardless of the location of the observer. In the past, optimal observation of emergency lights has occurred when an individual was either directly in front of, or behind, an emergency vehicle. Observation from the sides, or at an acute angle relative to the sides, frequently resulted in reduced observation of emergency lights during an emergency situation. A need therefore exists to improve the observation of emergency lights for a vehicle regardless of the location of the observer. A need also exists to improve the flexibility of placement of emergency lights upon a vehicle for

observation by individuals during emergency situations.

In the past, flashing light signals emanating from light bars have been used to signal the presence of an emergency situation necessitating caution. A need exists to reduce the size of light sources on an emergency vehicle and to improve the efficiency of the light sources particularly with respect to current draw and reduced aerodynamic drag. A need also exists to enhance the flexibility of positioning of light sources about a vehicle for observation by individuals. In order to satisfy these and other needs, more spatially efficient light sources such as LED's are required. It is also necessary to provide alternative colored LED light sources which may be electrically controlled for the provision of any desired pattern of light signal such as flashing, alternating, pulsating, oscillating, modulating, rotational, and/or strobe light effects without the necessity of spatially inefficient and bulky mechanical devices. In that regard, a need exists to provide a spatially and electrically efficient LED light source for use on an emergency vehicle which provides any of the above-identified types of warning light signals without the necessity of mechanical devices. In addition, a need exists to provide a spatially and electrically efficient LED light source for use on an emergency vehicle which provides a flashing, alternating, pulsating, rotating, modulated, oscillating, and/or strobe light effect or combinations thereof without the necessity of mechanical devices.

20

GENERAL DESCRIPTION OF THE INVENTION

According to the invention, there is provided a light emitting diode (LED) warning signal light which may be depicted in several embodiments. In general, the warning signal light may be formed of a single row or an array of light emitting diode light sources configured on a light support and in electrical communication with a controller and a power supply, battery, or other electrical source. The warning signal light may provide various light signals, colored light signals, or combination light signals for use by a vehicle. These light signals may include a strobe light, a pulsating light, a revolving light, a flashing light, a modulated or variable intensity light, an oscillating light, an alternating light, and/or any combination thereof. Additionally, the warning signal light may be capable of displaying symbols, characters, or arrows. Rotating and oscillating light signals may be produced by sequentially illuminating columns of LED's

on a stationary light support in combination with the provision of variable power intensity from the controller. However, the warning signal light may also be rotated or oscillated via mechanical means. The warning signal light may also be transportable for easy connection to a stand such as a tripod for electrical connection to a power supply, battery, or other electrical source as a remote stand-alone signaling device.

For the replacement LED lamp, extending from the standard mounting base may be a light source which one or a plurality of LED lamp modules which may be formed of the same or different colors as desired by an individual. Additionally, rotating and oscillating light signals may be produced by substitution of an LED light source in an oscillating or reflective light assembly. In addition, the warning signal light and/or replacement warning signal light may be electrically coupled to a controller used to modulate the power intensity for the light sources to provide for various patterns of illumination to create an illusion of rotation or other type of illusion for the warning signal light without the use of mechanical devices.

Alternative colored LED light sources may also be electrically controlled for the provision of any desired pattern of warning light signals such as flashing, pulsating, oscillating, modulating, rotational, alternating, and/or strobe light effects without the necessity of spatially inefficient and bulky mechanical devices.

Alternatively, a reflective light assembly may be provided. The reflective light assembly may rotate about a stationary light source or the light source may rotate about a stationary reflector. In another alternative embodiment, the reflective assembly may be positioned at an acute angle approximately 45° above a stationary LED panel or a solitary light source where the reflector may be rotated about a pivot point and axis to create the appearance of rotation for the light source. The light source may be utilized in conjunction with the reflective assembly and may also be electrically coupled to a controller for the provision of pulsating, oscillating, alternating, flashing, stroboscopic, revolving, variable, and/or modulated light intensity for observation by an individual.

The controller is preferably in electrical communication with the power supply and the LED's to modulate the power intensity for the LED light sources for provision of a desired type of warning light effect.

The warning signal light may be formed of an array of LED's, a single

row of LED's or a solitary LED mounted upon and in electrical communication with a substantially flat light support which includes a circuit board or LED mounting surface coupled to a power source. The light support may have dimensions of three inches by three inches or smaller at the discretion of an individual. Each light support may include
5 an adhesive, magnetic, and/or other affixation mechanism to facilitate attachment at various locations on and/or around an emergency vehicle. Each individual light support may be positioned adjacent to and be in electrical communication with another light support through the use of suitable electrical connections. A plurality of light supports or solitary light sources may be electrically coupled in either a parallel or series manner to
10 the controller at the discretion of an individual. A plurality of light sources each containing an array or singular LED may be in electrical communication with a power supply and a controller to selectively illuminate the LED's to provide for the appearance of a revolving, modulating, strobe, oscillating, alternating, pulsating, and/or flashing light source or any combinations thereof. The controller is preferably in electrical
15 communication with the power supply and the LED's to modulate the power intensity for the LED light sources for variable illumination of the LED light sources. The warning signal lights may encircle an emergency vehicle at the discretion of an individual. In addition, the light support may be encased within a waterproof enclosure to prevent moisture contamination and shorting of the LED light sources.

20 A principal advantage of the present invention is to provide a warning signal light capable of simulating revolving or oscillating light signals without the use of mechanical components.

Another principal advantage of the present invention is that the warning signal light is capable of producing several different types of light signals or
25 combinations of light signals.

Still another principal advantage of the present invention is to be rugged and have a relatively longer life cycle than traditional warning signal lights.

Still another principal advantage of the present invention is to produce a truer or pure light output color without the use of filters.

30 Still another principal advantage of the present invention is to allow the user to adjust the color of the light signal without having to make a physical adjustment

from a multi-colored panel.

Still another principal advantage of the present invention is that it may be formed into various shapes. This allows the invention to be customized for the particular need.

5 Still another advantage of the present invention is that the light signal produced may be easily customized by the user via a controller or microprocessor.

Still another principal advantage of the present invention is the provision of an LED light source which is formed of a relatively simple and inexpensive design, construction, and operation and which fulfills the intended purpose without fear of failure
10 or injury to persons and/or damage to property.

Still another principal advantage of the present invention is the provision of an LED light source which is flexible and which may easily replace existing illumination devices used as turn signals, brake lights, back-up lights, marker lights, and headlights in utility lens/reflector enclosures.

15 Still another principal advantage of the present invention is the provision of an LED light source for creation of bright bursts of intense white or colored light to enhance the visibility and safety of a vehicle in an emergency signaling situation.

Still another principal advantage of the present invention is the provision of an LED light source which is flexible and may easily replace existing illumination
20 devices at a much more economic expense and further having a reduced failure rate.

Still another principal advantage of the present invention is the provision of an LED light source which produces brilliant lighting in any of the colors associated with an emergency vehicle light signal such as red, blue, amber, green, and/or white.

Still another principal advantage of the present invention is the provision
25 of an LED light source which is highly resistant to corrosive effects and which is impervious to moisture build-up.

Still another principal advantage of the present invention is the provision of an LED light source which has an extended life cycle and continues to operate at maximum efficiency throughout its life cycle.

30 Still another principal advantage of the present invention is the provision of an LED light source which draws less current and/or has a reduced power requirement

from a power source for a vehicle.

Still another principal advantage of the present invention is the provision of an LED light source having improved reliability as compared to xenon gaseous discharge lamps, halogen lamps, and/or incandescent lamps as currently used on
5 emergency vehicles.

Still another principal advantage of the present invention is the provision of an LED light source which is simple and may facilitate the ease of installation and replacement of a xenon, halogen, and/or incandescent light source from a motor vehicle.

Still another principal advantage of the present invention is the provision
10 of an LED light source which reduces RF emissions which may interfere with other radio and electronic equipment in an emergency vehicle.

Still another principal advantage of the present invention is the provision of an LED light source which functions under cooler operating temperatures and conditions thereby minimizing the exposure of heat to adjacent component parts which,
15 in turn, reduces damage caused by excessive heat.

Still another principal advantage of the present invention is the provision of an LED light source having simplified electronic circuitry for operation as compared to xenon gaseous discharge lamps, halogen lamps, and/or incandescent lamps as used with an emergency vehicle.

Still another principal advantage of the present invention is the provision
20 of a warning signal light which may be easily visualized during emergency situations thereby enhancing the safety of emergency personnel.

Still another principal advantage of the present invention is the provision of a warning signal light which includes LED technology and which is operated by a
25 controller to provide any desired type or color of light signal including but not limited to rotational, pulsating, oscillating, strobe, flashing, alternating, and/or modulated light signals without the necessity for mechanical devices.

Still another principal advantage of the present invention is the provision of a warning signal light which is capable of simultaneously producing several different
30 types of light signals.

Still another principal advantage of the present invention is the provision

of a warning signal light which includes light emitting diode technology which is flexible and which may be attached to any desired location about the exterior of an emergency vehicle.

Still another principal advantage of the present invention is the provision
5 of an emergency warning signal light for emergency vehicles which has improved visualization, aerodynamic efficiency, and increased electrical efficiency.

Still another principal advantage of the present invention is the provision
of an LED light source which is flexible and which may be connected to a modulated
power source to provide variable power intensity for the light source which in turn is
10 used to create the appearance of rotation and/or oscillation without the use of mechanical rotation or oscillating devices.

A feature of the invention is the provision of a plurality of light emitting diodes (LED's), integral to a circuit board or LED mounting surface, where the LED's may be aligned in a single row or in vertical columns and horizontal rows.

Another feature of the invention is the mounting of a panel of LED's to a
15 mechanical device which rotates or oscillates the panel during use as a warning signal light on an emergency vehicle.

Yet another feature of the invention is the provision of a plurality of
LED's mounted to a flexible circuit board which may be manipulated into any desired
20 configuration and which may be used to produce rotating, oscillating, pulsating, flashing, alternating, and/or modulated warning signal light for an emergency vehicle.

Yet another feature of the invention is the provision of an LED support
member supporting an array of colored LED's and a controller capable of selectively
illuminating the LED's of the same color to produce a single or mixed colored light
25 signal.

Still another feature of the invention is the provision of a light emitting
diode support member having an array of LED's disposed about at least two sides and a
controller capable of producing light signals on each side which are independent of each
other.

Still another feature of the invention is the provision of an LED support
30 member having an array of LED's angularly offset with respect to the LED support

member for the provision of a horizontal light signal as viewed by an individual when the LED support member is mounted within the interior of the forward or rear windshield of a vehicle.

5 Still another feature of the invention is the provision of an LED support member which may be easily connectable and/or removed from a transportable support such as a tripod for placement of an LED warning signal light at any location as desired by an individual.

10 Still another feature of the invention is the provision of an LED support member which may be easily connectable to an emergency vehicle, including but not limited to automobiles, ambulances, trucks, motorcycles, snowmobiles, and/or any other type of vehicle in which warning signal or emergency lights are utilized.

15 Still another feature of the present invention is the provision a base having one or more LED's mounted thereon where said base is adapted for insertion into a standard one inch opening presently used for receiving xenon strobe tubes as a replacement LED warning light signaling light source.

Still another feature of the present invention is the provision a base having one or more LED's mounted thereon which is adapted for insertion into a mechanical device which rotates or oscillates a light source during use as a warning signal light on an emergency vehicle.

20 Still another feature of the present invention is the provision a microprocessor/controller which is in electrical communication with the LED light sources to selectively activate individual LED's to produce a flashing, strobe, alternating, rotating, oscillating, modulated and/or pulsating warning light signals.

25 Still another feature of the present invention is the provision an LED light signal which may be easily electrically coupled to a controller.

Still another feature of the present invention is the provision a warning signal light having a plurality of strip LED light sources affixed to the exterior of an emergency vehicle where the strip LED light sources are in electrical communication with a controller.

30 Still another feature of the present invention is the provision a warning signal light having a controller in electrical communication with a plurality of strip LED

light sources for the provision of modulated power intensity utilized to create the appearance of a rotational, pulsating, oscillating flashing strobe alternating , or modulated warning light signal.

Still another feature of the present invention is the provision an LED light
5 source where the power may be modulated by the controller to produce variable power intensity for the light sources to produce various desired patterns of illumination.

Still another feature of the present invention is the provision of a warning signal light having LED technology which includes an array, a single row or a solitary LED light source mounted to a light support.

10 Still another feature of the present invention is the provision of a strip warning signal light having LED technology which includes a light support having one or more LED light sources where the light support has a size dimension approximating three inches by three inches or smaller.

Still another feature of the present invention is the provision of a strip
15 warning signal light having LED technology where a plurality of strip LED light supports may be affixed in surrounding engagement to the exterior of an emergency vehicle.

Still another feature of the present invention is the provision of a strip warning signal light having LED technology where a light support is enclosed within a
20 transparent and water resilient enclosure to prevent water penetration and/or other contamination.

Still another feature of the present invention is the provision of a warning signal light having a plurality of light supports affixed to the exterior of an emergency vehicle where the controller is in electrical communication with each of the light
25 supports.

Still another feature of the present invention is the provision of a warning signal light having a controller in electrical communication with a plurality of light supports or single light sources for the provision of a modulated power intensity to the light sources.

30 Still another feature of the present invention is the provision of an LED light source where the power may be modulated by the controller to produce variable

power intensity for the light source to provide various desired patterns or combinations of patterns of illumination.

Still another feature of the present invention is the provision of an LED light source which includes a reflective device which rotates about the LED light source
5 to provide a warning light signal.

Still another feature of the present invention is the provision of an LED light source which includes a reflective device which is flat, concave, convex and/or parabolic for reflection of the light emitted for the LED light source.

Still another feature of the present invention is the provision of an LED
10 light source which includes a reflector mounted at an acute angel of approximately 45 degrees relative to the LED light source for reflection of light in a direction as desired by an individual.

Still another feature of the present invention is the provision of an LED light source which includes a reflector mounted at an acute angle of approximately 45
15 degrees relative to the LED light source where the reflector may be rotated about the LED light source for reflection of light in a direction as desired by an individual.

Still another feature of the present invention is the provision of an LED light source where a single LED light source or an array of LED light sources may be rotated and simultaneously a reflective device may be rotated to provide a warning signal
20 light.

Still another feature of the present invention is the provision of an LED light source which may include a conical shaped reflector or cullminator positioned above a light source.

Still another feature of the present invention is the provision of a rotatable
25 or stationary filter mounted between an LED light source and a reflector.

Still another feature of the present invention is the provision of a rotatable or stationary reflector which may include transparent and/or reflective sections.

Still another feature of the present invention is the provision of an LED light source where the individual LED light sources or arrays of LED light sources may
30 be rotated for transmission of light through the transparent and/or opaque sections of a filter for the provision of a unique warning signal light effect.

Still another feature of the present invention is the provision of a conical reflector which may include concave and/or convex reflective surfaces to assist in the reflection of light emitted from an LED light source.

- 5 Still another feature of the present invention is the provision of an LED light support having a longitudinal dimension and a single row of LED's which provide a desired type of warning light signal.

Still another feature of the present invention is the provision of an LED light support having a frame adapted to hold a circuit board or LED mounting surface.

- 10 Still another feature of the present invention is the provision of an LED light support where the circuit board or LED mounting surface includes one or more heat sink wells where an individual LED is positioned within each of the heat sink wells.

Still another feature of the present invention is the provision of an LED light support having one or more reflectors or elongate mirrors disposed in the frame to reflect light emitted from the LED light sources in a desired direction.

- 15 Still another feature of the present invention is the provision of an LED light support having a cullminator reflector which may be formed of one or more conical reflector cups which are utilized to reflect light emitted from the light sources in a direction desired by an individual.

- 20 Still another feature of the present invention is the provision of an LED light support having a lens cover attached to the frame to minimize water penetration or contamination exposure into the interior of the frame.

- Still another feature of the present invention is the provision of an LED light support having a positioning support functioning as a cullminator reflector which additionally positions individual LED's at a desired location relative to the interior of the
25 frame.

Still another feature of the present invention is the provision of an LED light support having a switch which may be manipulated to terminate power from a power supply or terminate communication to a controller.

- 30 Still another feature of the present invention is the provision of an LED light support having an affixation mechanism which may be integral or attached to the frame where the affixation mechanism is adapted to enable the light support to be

secured to a vehicle at a desired location.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial perspective view of an emergency vehicle equipped
5 with a light bar containing warning signal lights according to an embodiment of the invention;

FIG. 2 is a partial front elevation view of an emergency vehicle equipped
with a light bar containing warning signal lights referring to an embodiment of the invention;

10 FIG. 3 is a perspective view of a warning signal light attached to a gyrator according to an embodiment of the invention;

FIG. 4 is a perspective view of a warning signal light according to an
embodiment of the invention depicting the sequential activation of columns of light-
emitting diodes (LED's).

15 FIG. 5 is a perspective view of a warning signal light according to an
embodiment of the invention depicting sequential activation of rows of LED's;

FIG. 6 is a perspective view of a warning light signal according to an
embodiment of the invention;

20 FIG. 7 is a perspective view of a warning light signal according to an
embodiment of the invention;

FIG. 8 is a perspective view of a warning light signal according to an
embodiment of the invention;

FIG. 9 is a perspective view of a warning light signal according to an
embodiment of the invention;

25 FIG. 10 is a perspective view of a warning light signal according to an
embodiment of the invention;

FIGS. 1A, 11B, and 11C are schematic diagrams of the controller circuitry
in accordance with an embodiment of the invention;

30 FIG. 12 is a perspective view of a warning signal light according to an
embodiment of the invention;

FIG. 13 is a perspective detailed view of a warning signal light attached to
the interior of a windshield of an emergency vehicle;

FIG. 14 is a side plan view of a warning signal light mounted to an interior surface of an emergency vehicle window having auxiliary offset individual LED light sources;

FIG. 15 is an environmental view of a warning signal light as engaged to a remote support device such as a tripod;

FIG. 16 is a detailed isometric view of a xenon strobe tube and standard mounting base;

FIG. 17 is a detailed isometric view of the replacement LED light source and standard mounting base;

FIG. 18 is a detailed isometric view of an incandescent lamp light source and standard mounting base;

FIG. 19 is a detailed isometric view of a replacement LED lamp and standard mounting base;

FIG. 20 is a front view of a standard halogen light source mounted in a rotating reflector;

FIG. 21 is a detailed rear view of a rotating reflector mechanism;

FIG. 22 is a detailed front view of the LED light source mounted to a rotating reflector;

FIG. 23 is a detailed front view of a replacement LED light source;

FIG. 24 is a detailed side view of a replacement LED light source;

FIG. 25 is a detailed isometric view of a replacement LED light source and cover;

FIG. 26 is a detailed isometric view of a reflector or cullminator;

FIG. 27 is a detailed isometric view of a cullminator cup;

FIG. 28 is an alternative cross-sectional side view of a cullminator cup;

FIG. 29 is an alternative cross-sectional side view of a cullminator cup;

FIG. 30 is an alternative cross-sectional side view of a cullminator cup;

FIG. 31 is an exploded isometric view of an alternative cullminator assembly and LED light source;

FIG. 32 is an alternative partial cut away isometric view of an alternative cullminator assembly and LED light source;

FIG. 33 is an environmental view of an emergency vehicle having strip LED light sources;

FIG. 34 is an alternative detailed partial cut away view of a strip LED light source;

5 FIG. 35 is an alternative detailed view of an LED light source having sectors;

FIG. 36 is an alternative detailed view of a circuit board or LED mounting surface having heat sink wells;

FIG. 37 is an alternative detailed isometric view of a reflector assembly;

10 FIG. 38 is an alternative cross-sectional side view of the frame of a reflector assembly;

FIG. 39 is an alternative cross-sectional side view of a frame of a reflector assembly;

FIG. 40 is an alternative detailed side view of a reflector assembly;

15 FIG. 41 is an alternative detailed isometric view of a reflector assembly;

FIG. 42 is an alternative detailed side view of a reflector assembly;

FIG. 43 is a graphical representation of a modulated or variable light intensity curve;

20 FIG. 44 is an alternative detailed partial cross-sectional side view of a reflector assembly;

FIG. 45 is a partial phantom line top view of the reflector assembly taken along the line of 45-45 of Figure 44;

FIG. 46 is an alternative graphical representation of a modulated or variable light intensity curve;

25 FIG. 47 is an alternative isometric view of a reflector assembly;

FIG. 48 is a detailed back view of an individual LED light source;

FIG. 49 is a detailed front view of an individual LED light source;

FIG. 50 is a detailed end view of one embodiment of a reflector assembly.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

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A warning signal light according to the principles of the invention is indicated generally herein as numeral 10. FIGS. 1 and 2 depict light bar 70 mounted to an emergency vehicle 104. Light bar 70 includes base 72, mounting means 74, cover 82, and warning signal lights 10. Also included in light bar 70 are gyrators 90 used to impart motion to warning signal lights 10.

Referring to FIGS. 3 and 9, warning signal light 10 comprises light support 12, light sources 30, controller 50 (shown in FIG. 11), and connecting portion 40 for attaching the warning signal light 10 to light bar 70 or gyrator 90. The warning signal light 10 operates to create a warning signal for use by an emergency vehicle 104 by selectively activating light sources 30 using controller 50. Alternatively, warning signal light 10 may be formed of a solitary LED light source 30 at the discretion of an individual.

Light sources 30 are preferably light emitting diodes (LED's) and are generally arranged in aligned columns 32 and rows 34 as shown in FIG. 7 and 9. Each of the light emitting diodes (LED's) may have shoulder portion 38 adjacent LED support 12 and dome 36. LED's 30 are situated to be in electric communication with controller 50 and a power supply, a battery, or power source. The use of light emitting diodes (LED's) to replace traditional halogen, incandescent, or gaseous discharge xenon lamps reduces heat generation, current draw, and electromagnetic emissions, while increasing lamp life and producing a more true output light color.

The controller 50 is used to selectively activate columns 32, rows 34, or individual LED's 30, to illuminate any number of a plurality of visually distinct types of warning light signals at any moment; to illuminate more than one of a plurality of visually distinct types of warning light signals simultaneously at any moment; to illuminate one of a plurality of combinations or patterns of visually distinct warning light signals at any moment, or over any desired period of time, or to illuminate more than one of a plurality of combinations or patterns of visually distinct warning light signals over any desired period of time. The plurality of visually distinct warning light signals may include, but are not necessarily limited to, a strobe light signal, a pulsating light signal, an alternating light, a modulated light signal, a flashing light signal, the illusion of a rotating or an oscillating light signal, a reverse character message, or images such as arrows. It should be noted that the controller 50 may also incorporate into any selected warning

light signal variable or modulated power intensity to facilitate the provision of a desired unique lighting effect. For example, the controller 50 may illuminate one or more LED light sources 30 to establish a single warning light signal at a given moment.

Alternatively, the controller 50 may illuminate one or more light emitting diode light sources 30 to provide two or more warning light signals at any given moment. Further, the controller 50 may simultaneously, consecutively, or alternatively, illuminate one or more LED light sources 30 to establish any desired combination or pattern of illuminated visually distinct warning light signals at any given moment or over a desired period of time. The combination and/or pattern of visually distinct warning light signals may be random or may be cycled as desired by an individual. The illumination of one or more patterns or combinations of warning light signals facilitates the continued observation by an individual. Occasionally, the concentration or attention of an individual is diminished when exposed to a repetitive or to a monotonous light signal. The desired purpose for illumination of a warning light signal is thereby reduced. The provision of a pattern, combination, and/or random illumination of visually distinct warning light signals maximizes the concentration or attention to be received from an individual observing a warning light signal. The purpose of the warning light signal is thereby promoted.

FIGS. 11A, 11B, and 11C show an embodiment of controller 50 capable of selectively activating columns 32, rows 34 or individual LED's 30. Controller 50 generally comprises microprocessor 52 and circuitry 53 and is preferably contained within, attached to, or an element of, LED support 12. It is envisioned that controller 50 may be programmed by an external controller 55 and powered through cable R.

In one embodiment, controller 50 generally comprises circuit board 54 or LED mounting surface having microprocessor 52 attached to a low voltage power supply, battery, or electrical source 56. Microprocessor 52 is configured through circuitry 53 to selectively activate columns 32 of LED's 30. Transistors Q9 and Q10 are in electronic communication with microprocessor 52, power supply, battery, or electrical source 56, and their respective columns 32.9 and 32.10 of LED's 30. Columns 32 of LED's 30 are connected to transistors Q1-Q8, which are in turn connected to microprocessor 52 through resistors R1-R8. Microprocessor 52 is capable of selectively activating transistors Q1-Q8 to allow current flowing through transistors Q9 and Q-10 to

activate the selected column 32 of LED's 30. This circuit is capable of producing a strobe light signal, an alternating light signal, a modulated signal, a revolving light signal, a pulsating light signal, an oscillating light signal, or flashing light signal, a reverse character message, or images such as arrows.

5 In one embodiment, a rotating or oscillating light signal may be established by the sequential illumination of entire columns 32 of LED's 30 by turning a desired number of columns on and then sequentially illuminating one additional column 32 while turning another column 32 off. Alternatively, the rotating or oscillating warning light signal may be created by selectively activating columns 32 of LED's 30. The
10 following algorithm may be used to provide a counterclockwise revolving light signal (FIG. 9):

- 1) column A is activated at 0% duty cycle (column A 0%), column B 0%, column C 0%, column D 0%, column E 0%, column F 0%, column G 0%, column H 0%, column I 0%, and column J 0%;
- 15 2) column A 25%, column B 0%, column C 0%, column D 0%, column E 0%, column F 0%, column G 0%, column H 0%, column I 0%, and column J 0%;
- 3) column A 50%, column B 25%, column C 0%, column D 0%, column E 0%, column F 0%, column G 0%, column H 0%, column I 0%, and column J 0%;
- 4) column A 75%, column B 50%, column C 25%, column D 0%, column E 0%,
20 column F 0%, column G 0%, column H 0%, column I 0%, and column J 0%;
- 5) column A 100%, column B 75%, column C 50%, column D 25%, column E 0%, column F 0%, column G 0%, column H 0%, column I 0%, and column J 0%;
- 6) column A 100%, column B 100%, column C 75%, column D 50%, column E 25% column, column F 0%, column G 0%, column H 0%, column I 0%, and
25 column J 0%;;
- 7) column A 75%, column B 100%, column C 100%, column D 75%, column E 50%, F 25%, column G 0%, column H 0%, column I 0%, and column J 0%;

8) column A 50%, column B 75%, column C 100%, column D 100%, column E 75%, column F 50%, column G 25%, column H 0%, column I 0%, and column J 0%;

5 9) column A 25%, column B 50%, column C 75%, column D 100%, column E 100%, column F 75%, column G 50%, column H 25%, column I 0%, and column J 0%;

10) column A 0%, column B 25%, column C 50%, column D 75%, column E 100%, column F 100%, column G 75%, column H 50%, column I 25%, and column J 0%;

10 11) column A 0%, column B 0%, column C 25%, column D 50%, column E 75%, column F 100%, column G 100%, column H 75%, column I 50%, and column J 25%;

15 12) column A 0%, column B 0 %, column C 0%, column D 25%, column E 50%, column F 75%, column G 100%, column H 100%, column I 75%, and column J 50%;

13) column A 0%, column B 0%, column C 0%, column D 0%, column E 25%, column F 50%, column G 75%, column H 100%, column I 100%, and column J 75%;

20 14) column A 0%, column B 0%, column C 0%, column D 0%, column E 0%, column F 25%, column G 50%, column H 75%, column I 100%, and column J 100%;

15) column A 0%, column B 0%, column C 0%, column D 0%, column E 0%, column F 0%, column G 25%, column H 50%, column I 75%, and column J 100%;

25 16) column A 0%, column B 0%, column C 0%, column D 0%, column E 0%, column F 0%, column G 0%, column H 25%, column I 50%, and column J 75%;

- 17) column A 0%, column B 0%, column C 0%, column D 0%, column E 0%,
column F 0%, column G 0%, column H 0%, column I 25%, and column J 50%;
- 18) column A 0%, column B 0%, column C 0%, column D 0%, column E 0%,
column F 0%, column G 0%, column H 0%, column I 0%, and column J 25%;
- 5 19) column A 0%, column B 0%, column C 0%, column D 0%, column E 0%,
column F 0%, column G 0%, column H 0%, column I 0%, and column J 0%;
- 20) return to step 1).

A clockwise revolving light signal may be created by performing steps 1-
19 in descending order then repeating the steps. An oscillating light signal may be
10 created by performing: (a) steps 7 through 16 in ascending order; (b) steps 7 through 16
in descending order; and (c) repeating (a) and (b).

A second embodiment of controller 50 provides a means for activating
LED's 30 individually to allow for greater flexibility in the type of warning light signal
created. This embodiment of the invention is capable of displaying information in
15 different colors or patterns. Depending on the size of the display, it may be necessary to
scroll the symbols or characters across the display to accommodate for a larger visual
appearance. It is envisioned that the mirror image of patterns, symbols, or characters
could be displayed making the message easily readable by drivers viewing the signal in a
rear view mirror. It is also envisioned that this embodiment of the invention could
20 display arrows indicating a direction a vehicle is to travel or other images as shown in
FIG. 2. In addition, combinations of warning signal lights, direction arrows, and other
information carrying signals or images, could be displayed simultaneously by the
invention.

LED support 12 is envisioned to have several embodiments. One
25 embodiment, shown in FIG. 9, consists of a panel 14 having front 16, back 18, top 20,
bottom 22 and sides 24. LED's 30 are arranged on front 16, with domes 36 extending
therefrom, in columns 32 and rows 34. LED's 30 are in electric communication with
controller 50 which may be contained or sealed within LED support 12 to provide
protection from the elements.

Another embodiment of warning signal light 10 is depicted in FIG. 10. Here, the backs 18 of two panels 14 are attached together to allow for a light signal to be produced on two sides. The two panels 14 form LED support 12. Alternatively, it is envisioned that a single panel 14 having LED's arranged about front 16 and back 18 could be used as well.

FIGS. 6 and 8 show further embodiments of warning signal light 10. In FIG. 8, panels 14 are used to form an LED support 12 having four sides and generally shaped as squared. FIG. 6 shows panels 14 connected to form an LED support 12 having three sides and generally triangular in shape. In both embodiments, LED's 30 are arranged about the fronts 16 of the panels 14. It is further envisioned that panels 14 may be integral to each other.

Yet another embodiment of warning signal light 10, consists of a flexible panel 14 and controller 50 to allow LED support 12 to be formed into various shapes. FIG. 5 shows LED support 12 formed into a cylinder. Further variations include the use of flexible panels 14 to form other shapes such as semicircles (FIG. 12) or to simply conform to a surface of an emergency vehicle (FIGS. 13 and 14). This embodiment is particularly useful for undercover vehicles which generally position the warning signal lights inside the vehicle. For example, panel 14 could be attached to the front, rear, or side window of an undercover police vehicle.

It should be noted that numerous other shapes could be formed from panels 14 including those formed from combinations of flat, curved, and flexible panels at the preference of an individual.

In each of the embodiments discussed above, the array of LED's 30 may be formed of the same or differently colored LED's. Generally, each column 32 or row 34 may consist of a series of differently colored LED's. Controller 50 may be configured to select the color of the LED's to be illuminated forming the light signal. Accordingly, the user may select a blue, red, white, yellow, green, or amber color or any combination thereof to be used as the color of light signal. Alternatively, the warning signal 10 may be formed of individual LED's 30 which may be selectively illuminated at the discretion of an individual.

It is also envisioned that the controller 50 may control warning signal lights 10 having multiple sides (FIGS. 5, 6, 8, and 10) such that each side is capable of

producing warning light signals or combination warning light signals that are independent and/or different from those produced upon the other sides. For example, the squared shape warning signal light shown in FIG. 8 may produce or simulate a red revolving light on first side 15.1, while second side 15.2 is simultaneously producing a blue oscillating light, while third side 15.3 is producing or simulating a stationary white light, and while fourth side 15.4 is producing a white strobe light.

Another embodiment of warning signal light 10 is depicted in FIGS. 1 and 2 as light bar 70 which extends from driver side 100 to passenger side 102 of emergency vehicle 104. Cover 82 protects light bar 70 from the elements. Each side of light bar 70 may have LED's 30 to produce or simulate warning light signals on each side of emergency vehicle 104. Furthermore, controller 50 may be used to create multiple warning light signals on each side of light bar 70. For example, controller 50 may create a simulated revolving blue light positioned at front passenger side 102 of light bar 70, oscillating white lights positioned at front driver side 100, and yellow arrows there between. Additional or alternative warning light signals may be produced out the back 18 and sides of light bar 70. It is further envisioned that light bar 70 may consist of a single light source, a single row of light source or a large array of LED's 30 across each side (not shown). This embodiment provides the largest display and, therefore, is best suited to display desired combinations of warning lights and images. It should be noted that the identified types of warning light signals, combinations and/or patterns of warning light signals, may also be reproduced through the illumination of a single row of LED light sources 30.

Mechanical rotation and oscillation of warning signal lights 10 about axis A is possible by way of attachment to gyrator 90 depicted in FIG. 3. Gyrator 90 mounted to light bar 70, generally comprises electric motors 96 having cables 97. Gyrator 90 is configured to receive connecting portion 40 of warning signal light 10. Cable 97 is preferably connected to a power supply and either an external controller 55 or controller 50.

Gyrator 90 may be capable of rotating or oscillating warning signal light 10 about a single or dual axis of rotation A. FIG. 3 shows gyrator 90 configured to rotate or oscillate warning signal light 10 about a vertical axis A by way of motor 96.1 and oscillate warning signal light 10 about a horizontal axis A by way of motor 96.2.

Rotation or oscillation of warning signal light 10 about vertical axis A is accomplished through direct attachment of connecting portion to motor 96.1. Oscillation of warning signal light 10 about horizontal axis A is accomplished by attaching swivel arm 99 to bracket 99.1 and post 99.2 which is mounted to motor 96.2.

5 Alternative methods for imparting rotation or oscillation motion to warning signal light 10 may be accomplished through the use of electric motors, toothed gears, and worm gears. In addition, maintaining electrical communication between a power supply and an external controller 55 with a revolving or oscillating warning signal light 10 may be accomplished using brushes or other means without sacrificing the
10 operation of the warning signal light 10.

 In another embodiment as depicted in FIGS. 13 and 14, emergency vehicle 104 may include a front or rear windshield 106. The front or rear windshield 106 is generally angularly offset with respect to the vehicle at an approximate angle of 45 degrees. In this embodiment, the mounting of a panel 14 of light sources 30 in flush
15 contact with the interior of a front or rear windshield 106 occurs through the use of angular offsets 108 for the light sources 30 such that light emitted from the light sources 30 occur at a horizontal visual line (V) which is substantially parallel to the plane of a vehicle and not at an approximate angle of 45 degrees upward, which corresponds to the angle for the front or rear windshield 106.

20 In this embodiment, the ease of visualization of the light source 30 is significantly enhanced by the downward angular offsets 108 which position the light sources 30 along parallel visual lines of sight (V). LED supports 12 or panels 14 may then be positioned in any desired location within the interior of a vehicle in flush contact or proximate to the front or rear windshield 106. A suitable cable 97 is required to
25 provide electrical power for illumination of the light sources 30. It should be noted that the angle of incidence for the angular offsets 108 may vary considerably dependent upon the make or model for the vehicle to include the warning signal lights 10.

 It should be further noted that the warning signal light 10 may be used with an automobile, motorcycle, snowmobile, personal water craft, boat, truck, fire
30 vehicle, helicopter, and/or any other type of vehicle receptive to the use of warning signal lights 10. It should be further noted that LED support 12 or panel 14 may be mounted to the interior top dashboard of a vehicle proximate to the front windshield 106 or to the

interior top rear dashboard proximate to the rear windshield 106 of a vehicle.

Mounting of a light support 12 or panel 14 to either the front or rear dashboards may minimize the necessity for inclusion of angular offset 108 for the light sources 30. It should be further noted that LED supports 12 or panels 14 may be
5 releasably affixed to the interior of the front or rear windshields 106 via the use of suction cups, hook-and-loop fabric material such as Velcro®, and/or any other releasable affixation mechanism at the preference of an individual. An individual may then adjust and reposition the location of the light support 12 or panels 14 anywhere within the interior of a vehicle as desired for maximization of visualization of the warning signal
10 lights 10.

In another alternative embodiment as depicted in FIG. 15, warning signal light 10 may function as a remote, revolving, or stationary beacon. In this embodiment, LED support 12 or panel 14 is preferably releasably connected to a transportable support
15 120 via the use of a bracket. The transportable support 120 may be a tripod having telescoping legs or may be any other type of support as preferred by an individual. In this embodiment, LED light support 12 or panel 14 is electrically connected to an elongate electrical extension cable 97 which may include any desired adapter for electrical connection to a power source which may be a vehicle. The remote light support 12 or
20 panel 14 may also include plug-in adapters for electrical connection to any desired electrical power source other than a vehicle as is available.

The transportable support 120 may also include gyrator 90 as earlier described to provide a desired rotational or oscillatory motion for warning signal light 10. A controller 50 having a microprocessor 52 may also be integral to, or in electrical communication with, LED's 30 for the provision of multi-colored lights, flashing,
25 alternating, modulated, moving characters, arrows, stroboscopic, oscillating and/or revolving warning light signals as desired by an individual. In this embodiment, the warning signal light 10 may be physically separated from an emergency vehicle 104 any desired distance to facilitate or enhance the safety of a potentially dangerous situation necessitating the use of warning signal lights 10. In addition, it should be noted that a
30 series of remote warning signal lights 10 may be electrically coupled to each other for any desired distance to again facilitate the safety of a situation necessitating the use of warning signal lights 10.

FIG. 16 shows a perspective view of a xenon lamp 1. Xenon lamp 1 has a base pedestal 2 which is typically formed of rubber, plastic, or other insulating material. Base pedestal 2 has a top surface 3 which may support a glass tube 4 which may have a looped curve such that an anode end and a cathode end are each supported on a top surface. The anode and cathode ends may be sealed and respective electrical conductors 5 and 6 may pass through the sealed ends and through the top surface 3. A trigger wire 7 may be helically wound about the exterior surface of the glass tube 4 and the ends of the trigger wire 7 may be passed through the top surface 3 of the base pedestal 2 to form a third conductor on the underside of the base pedestal 2.

Base pedestal 2 may have an upper cylinder portion 8 extending from a lower shoulder all of which may extend above the top surface 3. The upper cylindrical portion 8 may include an upper shoulder 9. A glass dome (not shown) may be sized to fit over the xenon lamp 1 and glass tube 4 for resting on the upper shoulder 9. The glass dome may be preferably made from a transparent or silicate glass material capable of withstanding heat stress. The outer diameter of the glass dome is typically about one inch which is sized to fit through the conventional opening in a typical vehicle lamp fixture. The exterior glass dome surface typically has a much lower temperature during operation than the exterior surface of the glass tube 4 forming a part of the xenon lamp 1. The temperature drop between the glass tube 4 and the glass dome facilitates the use of coloring of the dome to provide a colored lamp by virtue of the xenon light intensity passing through the colored dome.

The xenon lamp 1 is preferably aligned for insertion into a conventional opening 248 of a light reflector 260 (FIGS. 20 and 21). The light receptacle opening 248 in the light reflector 260 is typically about one inch in diameter; and the glass dome and base pedestal 2 are preferably sized to fit within the light receptacle opening 248. The xenon lamp 1 in its final construction may include a cover plate (not shown) affixed over the bottom opening of the base pedestal 2 for affixation to a light reflector 260 via the use of screws which pass through the screw apertures 9.1. The anode, cathode, and trigger wire 7 preferably traverse the base pedestal 2 and may include a plug 9.2 which is adapted for engagement to a controller/power supply for a motor vehicle.

The light reflector 260 may be a conventional light reflector of the type found in vehicles having a clear plastic or glass lens cover. The glass or lens cover may

be fitted over the front edge of the reflector 260 in a manner which is conventional with vehicle lamps. It should be noted that the light reflector 260 may be parabolically or other shaped at the preference of an individual. The light reflector 260 may be mounted to a motor for rotation about a vertical axis. In this embodiment the light

- 5 source/replacement lamp 200 may be integrally connected or affixed to the reflector 260 for simultaneous rotation about the vertical axis during use of the motor. Alternatively, the light source/replacement lamp 200 may be fixed proximate to the vertical axis where the light reflector 260 is rotated around the stationary replacement lamp 200 to provide for the visual appearance of a rotational light source.

- 10 The glass domes as used with the xenon lamps 1 may be colored with any color as preferred by an individual including but not limited to red, blue, amber, green, and/or white. It should be noted that the light fixture incorporating the light reflector 260 may be a headlight fixture or a turn signal light fixture where the xenon lamp 1 is mounted into the light reflector 260 on either side of a centrally-mounted halogen light
- 15 bulb which may be used as a headlight lamp. In this case, the light fixture could perform its normal function as a headlight and could alternatively flash several additional colors, depending upon the needs of the user. This configuration provides an emergency flashing light construction which is wholly concealed within a normal head lamp of a vehicle and is, therefore, not readily visible from outside the vehicle unless the lights are
- 20 flashing. This construction may find application in an unmarked emergency vehicles such as might be used by some law enforcement officers.

- In operation, the LED replacement lamp 200 may be constructed as a replacement part for a conventional incandescent or xenon gaseous discharge lamp. The standard mounting base 204 and LED support assembly 212 may be sized to readily fit
- 25 into the same light opening as an incandescent lamp would require, although it is apparent the electrical driving circuit for the LED replacement lamp 200 may require modifications to accommodate the LED operating principles.

- LED warning signal lamp 200 may be used in a variety of locations about a vehicle. It should be noted that the use of the LED warning signal lamps 200 are not
- 30 necessarily limited to positioning adjacent to the head lamp or headlight, tail light, or turn signal illumination devices for an emergency vehicle 104. The LED warning signal lamp 200 may be used as a rotational, pulsating, or oscillating reflector light within the

interior adjacent to a front, rear, and/or side window of a vehicle.

It is also envisioned that the controller 50 may control warning signal lights 200 independently of one another such that each warning signal lamp 200 is capable of producing warning light signals which are independent and/or different from those produced at another location about an emergency vehicle 104. For example, a front left location may produce a red colored light while simultaneously a front right location may produce an amber colored light and a right rear location may produce a green colored light and a left rear location may produce a blue colored light. The controller 50 may then alternate the color of the light illuminated from the warning signal lamp 200 in each area as desired by an individual. Alternatively, the controller 50 may sequentially activate warning signal lamps 200 positioned about an emergency vehicle 104 to simultaneously produce a desired color or alternating sequence of colors. It should also be noted that the controller 50 may simultaneously illuminate all LED warning signal lamps 200 to produce a flashing or strobe light which may be particularly useful in certain emergency situations. It should be further noted that the controller 50 may selectively illuminate individual LED warning signal lamps 200 in any desired color, pattern, and/or combination as desired by an individual.

Referring to FIG. 17 in detail, an LED replacement lamp 200 is depicted. In this embodiment the LED replacement lamp 200 includes a standard mounting base 204 which preferably includes a top surface 206. Extending upwardly from the top surface 206 is preferably an upper cylindrical portion 208 which includes an upper shoulder 210. Extending upwardly from the upper shoulder 210 is preferably an LED support assembly 212 which includes one or more LED lamp modules 213. The LED lamp modules 213 may be of the same or different colors at the discretion of an individual. A wire 202 is preferably in electrical communication with the plurality of LED lamp modules 213 to provide for electrical communication with the controller 50 to individually activate or illuminate LED lamp modules 213 as preferred by an individual. A plug-in connector 40 is preferably coupled to the wire 202 for engagement to the controller 50 and/or power source of an emergency vehicle 104.

The LED replacement lamp 200 is preferably adapted to be positioned in a one inch light receptacle opening 248 (approximate size) which has been previously placed through the backside of a reflector assembly 260. The LED replacement lamp

200 is preferably used to replace a xenon gaseous discharge lamp or incandescent lamp as previously mounted to a base which is inserted into opening 248 in a reflector assembly 260. Illumination of one or more individual LED lamp modules 213, as mounted in the reflector assembly 260, enables the reflector assembly/lens to take on the appearance of a warning signal or emergency signaling lamp. The LED replacement lamp 200 preferably replaces the xenon gaseous discharge or incandescent lamp assemblies with high brightness, long life LED technology.

Referring to FIG. 18, an incandescent lamp or quartz halogen H-2 lamp is depicted and in general is indicated by the numeral 220. The incandescent lamp assembly 220 is preferably formed of a standard mounting base 222. A vertical post 224 preferably extends upwardly from the standard mounting base 222. The incandescent light bulb 226 is preferably mounted in the vertical post 224. The vertical post 224 may extend below the standard mounting base 222 to provide for electrical coupling with a wire 228 which preferably includes a standard pin connector 230. The standard pin connector 230 is preferably adapted for electrical communication to a power supply and/or controller 50 for activation of the incandescent lamp assembly 220. The incandescent lamp assembly 220 may be stationary or mounted in a rotational light reflector 260 as desired by an individual. The light bulb 226 may be a halogen H-2, 55 watt, lamp at the discretion of an individual.

As depicted in FIG. 19, LED replacement lamp 200 is adapted to replace the incandescent lamp assembly 220 in a stationary or rotational light reflector 260. The LED replacement lamp 200 as depicted in FIG. 19 preferably includes a standard mounting base 234 and a vertical post 236. It should be noted that the vertical post 236 may extend upwardly from the standard mounting base 234 and may alternatively extend below the standard mounting base 234 at the preference of an individual. An LED mounting area 238 may be preferably integral or affixed to the upper section of the vertical post 236. The LED mounting area 238 preferably includes a plurality of individual LED module lamps 240 which may be individually, sequentially, or illuminated in combination with other light sources at the preference of an individual.

The individual LED module lamps 240 are preferably in electrical communication with a wire 242 which includes an integral standard wire connector 244. The wire connector 244 is preferably adapted to be plugged into a controller 50 or power

supply. Communication is thereby provided for selective illumination of the individual LED module lamps 240. It should be noted that a group of individual LED module lamps 240 are mounted in the LED mounting area 238. It should also be noted that the LED replacement lamp 200 is preferably adapted to replace the incandescent lamp assembly 220 or a xenon gaseous discharge lamp assembly base of FIGS. 16 or 18. The purpose of the LED replacement lamp assembly 200 is to replace existing xenon gaseous discharge and incandescent lamps with new LED technology while simultaneously utilizing existing standard bases in a standard lamp enclosure. For example, an individual may choose to replace a halogen "H-2" 55 watt lamp with an "LED-2" lamp in an existing rotating light fixture with no other structural modifications, yet achieving the advantages of less power consumption, greater reliability, easier installation, less RF emissions (which reduces interference with radio or electronic equipment), cooler operating temperatures, simplified circuitry, longer life, greater durability and duty capability, and simultaneously providing pure and easier-to-see color light output.

As depicted in FIG. 20, a rotational light reflector 246 is disclosed. The rotational light fixture 246 includes a reflector assembly 260 having a standard opening 248. The incandescent light assembly 220 is preferably positioned in the standard opening 248 for extension of the vertical post 224 outwardly from the reflector assembly 260 for positioning of the light bulb 226 in a desired location. Light emitted from the standard halogen light bulb 226 preferably reflects off the parabolic-shaped reflector assembly 260 for transmission of light in a direction as indicated by arrows AA for visualization by individuals. Reflector assembly 260 and light source 226 may be rotated via the use of gears 250 which are preferably driven by electrical motors not shown. In this manner, the rotational light fixture 246 including the reflector assembly 260 may be rotated at any desired velocity as preferred by an individual.

As may be seen in FIG. 21, a rear or back view of the rotational light fixture 246 is provided. As may be seen in FIG. 21, the light source is preferably positioned in the standard opening 248. The wire 228 as in electrical communication with the light source and is preferably connected via the standard pin connector 230 for electrical communication with a power source.

As depicted in FIG. 22, an alternative rotational light fixture 252 is depicted. Rotational light fixture 252 preferably includes a reflector assembly 260 which

may be parabolic in shape for the transmission of light along a common axis as depicted by arrows BB for visualization by an individual. In this embodiment, the individual LED module lamps 240 may be positioned to the front of the reflector assembly 260 through the use of a frame 254. The frame 254 may be integral or connected to a gear 250 as desired by an individual. The gear 250 may be driven by a motor for rotation of the light fixture 252. It should be noted that the individual LED module lamps 240 are preferably in electrical communication with a power source not shown.

It should be further noted that the rotational light fixture 252 may also be adapted for the provision of an oscillating or pulsating warning light signal at the preference of an individual.

An alternative replacement LED lamp 200 is depicted in FIGS. 23-25. In this embodiment the LED replacement lamp 200 includes a standard mounting base 270. The standard mounting base 270 also preferably includes a plurality of teeth 272. The teeth 272 are preferably adapted for mating coupling with gears integral to a motor and/or reflector 260, or rotational light fixture 246 to facilitate rotation and/or oscillation of the replacement LED lamp 200. The standard mounting base 270 also preferably includes a top surface 274 opposite to the teeth 272.

An upper cylinder portion 276 is preferably adjacent to the top surface 274. The upper cylinder portion 276 preferably includes an upper shoulder 278. Extending upwardly from the upper shoulder 278 is preferably a circuit board, LED mounting surface, or support 280 which preferably includes one or more LED illumination sources 282. The LED illumination sources 282 may be of the same or different colors at the preference of an individual. A wire 284 is preferably in electrical communication with the LED illumination sources 282 to provide for communication and contact with the controller 50 for combination and/or individual illumination of the LED illumination sources 282. A standard plug-in connector may be integral to the wire 284 to facilitate coupling engagement to the controller 50 and/or power source for a vehicle 104.

The circuit board or LED mounting surface 280 is preferably adapted to have a first side 286 and an opposite side 288. Preferably a plurality of LED illumination sources 282 are disposed on both the first side 286 and the opposite side 288 of the replacement lamp 200.

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A glass dome or protector 290 is preferably adapted for positioning over the circuit board or LED mounting surface 280 for sealing engagement to the top surface 274 of the standard mounting base 270. The glass dome 290 may be formed of transparent plastic material or a transparent or silicate glass material capable of withstanding heat stress at the preference of an individual. It should be further noted that the glass dome 290 preferably protects the circuit board or LED mounting surface 280 and the LED illumination sources 282 from contamination and from exposure to moisture during use of the replacement lamp 200. In this regard, the sealing lip 292 of the glass dome 290 preferably is securely affixed to the top surface 274 to effectuate sealing engagement therebetween. The outer diameter of the glass dome 290 is preferably about one inch which is sized to fit within the conventional opening 248 in a typical lamp fixture or reflector assembly 260.

The replacement lamp 200 depicted in FIGS. 23, 24, and 25 is also adapted to be positioned in a one inch light receptacle opening 248 which has been placed into a reflector assembly 260. Illumination of one or more individual LED illumination sources 282 as disposed on the circuit board or LED mounting surface 280 enables the replacement lamp 200 to take on the appearance of a warning signal or emergency signaling lamp.

The replacement lamp as depicted in FIGS. 23, 24, and 25 may alternatively permit the circuit board 280 to extend below the upper shoulder 278 to facilitate affixation and positioning relative to the standard mounting base 270.

The controller 50 may regulate the illumination of the LED light sources 282 individually, or in combination, to provide a desired warning lighting effect for the replacement lamp 200. Also, the controller 50 may illuminate the LED light sources 282 individually, or in combination, independently with respect to the first side 286 and the opposite side 288 to provide different warning light effects to be observed by an individual dependant upon the location of the person relative to the replacement lamp 200. The controller 50 may also simultaneously or independently regulate the power intensity to the LED illumination sources 282 to provide for a modulated or variable light intensity for observation by an individual. It should also be noted that the LED illumination sources 282 may be formed of the same or different colors at the preference of an individual to provide a desired type of warning light effect for the replacement

lamp 200.

In an alternative embodiment, the LED warning signal lamps 10 or LED replacement lamps 200 may be electrically coupled to a controller 50 which in turn is used to provide a modulated power intensity for the light source. A modulated power intensity enables the provision of various power output or patterns of illumination for creation of a plurality of visually distinct warning light signals without the use of mechanical devices. In these embodiments, the controller 50 illuminates selected light sources 282 and the controller 50 may also regulate and/or modulate the power supplied to the light source 282 thereby varying the intensity of the observed light. In addition, the controller 50 may modulate the power supplied to the LED warning signal lamps 10 or LED replacement lamps 200 in accordance with a sine wave pattern having a range of 0 to full intensity. At the instant of full intensity, the controller 50 may also signal or regulate a power burst for observation by an individual. The controller 50 operating to regulate and/or modulate the power intensity for the warning signal lamps 10 or LED replacement lamps 200 in conjunction with illumination and non-illumination of selected light source 282 may establish the appearance of a rotational warning light source or pulsating light source without the necessity of mechanical rotational or oscillating devices. The current draw requirements upon the electrical system of an emergency vehicle 104 is thereby significantly reduced. Spatial considerations for an emergency vehicle are also preferably optimized by elimination of mechanical, rotational and/or oscillation devices.

The controller 50 may also regulate the modulated power intensity for the provision of a unique variable intensity warning light signal. The unique variable intensity light source is not required to cycle through a zero intensity phase. It is anticipated that in this embodiment that the range of intensity will cycle from any desired level between zero power to full power. A range of power intensity may be provided between thirty percent to full power and back to thirty percent as regulated by the controller 50. It should also be further noted that an irregular pattern of variable power intensity may be utilized to create a desired type of warning light effect. In addition, the controller 50 may also sequentially illuminate adjacent columns 32 to provide a unique variable rotational, alternating, oscillating, pulsating, flashing, and/or combination variable rotational, alternating, pulsating, oscillating, or flashing visual warning light

effects. A pulsating warning light signal may therefore be provided through the use of modulated power intensity to create a varying visual illumination or intensity effect without the use of rotational or oscillating devices. The controller 50 may also modulate the power intensity for any combination of light sources 30 or 282 to provide a

5 distinctive or unique type of warning light signal.

The use of a controller 50 to provide a modulated power intensity for a light source may be implemented in conjunction with replacement lamps 200, flexible circuit boards having LED light sources 30, paneled circuit boards or LED mounting surfaces having LED light sources 30, light bars 70 having LED light sources 30, a
10 cylindrical, square, rectangular, or triangular-shaped circuit boards having LED light sources 30 and/or any other type or shape of LED light sources including but not limited to the types depicted in FIGS. 1-50 herein.

Further, the controller 50 may be utilized to simultaneously provide modulated or variable light intensity to different and/or independent sections, areas,
15 and/or sectors 326 of a light source (Fig. 35). Also, the controller 50 may be utilized to simultaneously provide modulated or variable light intensity to different and/or independent sectors, areas, and/or sections 326 of the forward facing side or rearward facing side of the light bar 70 for the provision of different warning light signals or a different warning light effects on each side. In this embodiment it is not required that the
20 forward facing and rearward facing sides of the light bar 70 emit the identical visual patterns of illuminated light sources 30. The controller 50 may regulate and modulate the variable light intensity of any desired sector 326 of the forward facing side independently from the rearward facing side of the light bar 70. The controller 50 may thereby provide any desired pattern and/or combination of patterns of warning light signals through the
25 utilization of variable and/or modulated light intensity for the forward facing side, and a different type or set of patterns and/or combination of patterns of warning light signals having variable or modulated light intensity for the rearward facing side of the light bar 70 as desired by an individual. It should be further noted that an infinite variety of patterns and/or combinations of patterns of warning light signals may be provided for the
30 forward facing side and the rearward facing side of the light bar 70 a the preference of an individual.

The use of the controller 50 to modulate the power intensity for a light

source 30 to provide a unique warning light signal may be utilized within any embodiment of an LED light source 10, light bar 70 light support, replacement lamp 200 or reflector assembly as described in figures 1-50 herein.

It should be further noted that the modulation of the power intensity for a light source 30 or replacement lamp 200 may be used in conjunction, or as a replacement to, the sequential illumination of rows, columns, and/or individual LED light sources 30 to provide a desired type of unique warning light effect.

The modulated power intensity may be regulated by the controller 50 to create a unique warning light signal within a single sector 326 or in conjunction with multiple separated or adjacent sectors 326 of light bar 70 or light support for the provision of any desired composite emergency warning light signal. All individual LED light sources 30 within a light bar 70 or light support may be simultaneously exposed to incrementally increased modulated power intensity to provide for an incremental increase in illumination. A power burst at full power may be provided at the discretion of an individual. The modulation of the power intensity in conjunction with the incremental increase in illumination of all LED light sources 30 within light bar 70 or light support may provide the appearance of rotation of a warning light signal when observed by an individual. The power exposed to the individual light sources 30 may then be incrementally decreased at the preference of an individual. It should be noted that the power is not required to be regularly incrementally increased or decreased or terminated. It is anticipated that any pulsating and/or modulated variable light intensity may be provided by the controller 50 to the LED light sources 30.

It should also be noted that all individual LED light sources 30 within a light bar 70 are not required to be simultaneously and incrementally illuminated to provide for the appearance of rotation. For example, a light bar 70 or light support may be separated into one or more distinct segments 326 which are formed of one or more columns 32 of LED light sources 30. a particular segment 326 may be selected as a central illumination band which may receive the greatest exposure to the modulated or variable power intensity and, therefore, provide the brightest observable light signal. An adjacent segment 332 may be disposed on each side of the central illumination band 330 which in turn may receive modulated or variable power intensity of reduced magnitude as compared to the central illumination band 330. A pair of removed segments 333 may

be adjacent and exterior to the segments 332, and in turn, may receive exposure to a modulated power source of reduced intensity as compared to segments 332. The number of desired segments may naturally vary at the discretion of an individual. The controller 50 may thereby regulate a power source to provide a modulated or variable power intensity to each individual segment 330, 332, or 333 (figure 35) to provide for a unique warning light effect for the light bar 70 or light support.

It should be further noted that light supports 12 may be flat and rigid, pliable, moldable, triangular, cylindrical, partially cylindrical, and/or any other shape as desired by an individual provided that the essential functions, features, and attributes described herein are not sacrificed.

The provision of a modulated power intensity to the light bar 70 or light support may also be coupled with or in combination to the sequential illumination of columns 32 as earlier described. In this situation, the warning light signal may initially be dim or off as the individual columns 32 are sequentially illuminated and extinguished for illumination of an adjacent column or columns 32. The power intensity for the illuminated column or columns 32 may simultaneously be incrementally increased for a combination unique rotational and pulsating modulated or variable warning light signal. In addition, the controller 50 may be programmed to provide the appearance of rotation pulsation and/or oscillation at the discretion of an individual.

Each individual LED light source 30 preferably provides an energy light output of between 20 and 200 or more lumens as desired by an individual.

Each light support 12 may contain a plurality of rows 34 and columns 32 of individual LED light sources 30. The light supports 12 are preferably in electrical communication with the controller 50 and power supply. The supports 12 preferably are controlled individually to create a desired warning light signal for an emergency vehicle 104 such as rotation, alternating, oscillation, strobe, flashing, or pulsating as preferred by an individual. Each support 12 may be controlled as part of an overall warning light signal or pattern where individual supports 12 may be illuminated to provide a desired type or combination light signal in addition to the provision of a modulated or variable power intensity for the light source 30.

Modulated power intensity may be regulated by the controller 50 to create the appearance of rotation within a single support 12 or in conjunction with multiple

separated, independent or adjacent supports 12 for the provision of a composite emergency warning light signal.

It should be noted that each portion, section, sector, or area 326 of light bar 70 or light support may be controlled as part of an overall warning light signal or pattern where individual sections or sectors 326 may be illuminated to provide a desired type of warning light signal including but not limited to rotation and/or oscillation through the use of a modulated or variable power intensity. Alternatively, the controller 50 may provide for the random generation of light signals without the use of a preset pattern at the preference of an individual.

Controller 50 may be used to selectively activate individual LED's 30 to create a pulsating light signal, a strobe light signal, a flashing light signal, an alternating light signal, and/or an alternating colored flashing light signal for an emergency vehicle.

Controller 50 provides a means for activating LED's 30 individually to allow for greater flexibility in the type of warning light signal created. This embodiment of the invention is also capable of displaying information in a variety of different colors or sequential illumination of colors.

Referring to figure 33, the emergency vehicle 300 preferably includes a light bar or light support 302 which may include one or more panels of LED light sources 306. A strip LED light source 308 may also be secured to the exterior of the emergency vehicle 300 at any location as desired by an individual. It is anticipated that the strip LED light source 308 may preferably encircle an entire emergency vehicle 300 to enhance the visualization of the emergency vehicle 300 as proximate to an emergency situation.

Referring to FIG. 34, the strip LED light source 308 is preferably comprised of a circuit board 310 having an array 312 of individual LED light sources 306. The LED light sources 306 are preferably in electrical communication with each other via electrical contacts 314. Each circuit board 310 is preferably in electrical communication with a power supply and/or controller 50 via the use of wires 316. Each individual LED light source 306 as included within a strip LED light source 308 may be enclosed within a reflector 370 to facilitate and maximize light output along a desired visual line of sight. It should be noted that the LED light sources 306 preferably have maximum illumination at an angle of incidence approximately 40°-45° downwardly

from vertical. The strip LED light sources 308 preferably include a back-side. The back-side preferably includes an adhesive, magnetic, or other affixation device which may be used to secure the strip LED light sources 308 to the exterior of an emergency vehicle 300 in any desired pattern or location. The strip LED light sources 308 may also be
5 enclosed within a transparent cover 324 which prevents moisture or other contamination from adversely affecting the performance of the LED light sources 306 during use of the strip LED light source 308.

Wires of adjacent strip LED light sources 308 may preferably be intertwined to extend across a vehicle for coupling to a power supply at a central
10 location. The wires are preferably connected to the controller 50 which may be used to regulate the illumination of individual LED light sources 306 and/or individual panels of the strip LED light sources 308 to provide for the appearance of sequential, pulsating, alternating, oscillating, strobe, flashing, modulated, and/or rotational lights for an emergency vehicle 300. It should be noted that the individual LED light sources 306
15 within the strip LED light source 308 may be of a single or variety of colors as desired by an individual. Alternatively, adjacent strip LED light sources 308 may be electrically coupled to each other in a parallel or series electrical connection for communication to a centrally located controller and power source.

The individual LED light sources 306 as incorporated into the array 312
20 of the strip LED light sources 308 are preferably sturdy and do not fail or separate from a vehicle 300 when exposed to rough operating conditions. It should be further noted that any individual strip of LED light sources 308 may be easily replaced as required. The transparent cover 324 for the strip LED light sources 308 is preferably formed of sturdy and resilient plastic material which prevents water penetration and/or contamination to
25 the circuit board 310 and/or individual light sources 306. Each individual LED light source 306 preferably provides an energy light output of between 20 and 200 or more lumens as desired by an individual.

The strip LED light sources 308 may individually be any size as preferred by an individual. It is anticipated that the strip LED light sources 308 may have the
30 approximate dimensions of three inches in length, three inches in width, and one-half inch in thickness for use in affixation to the exterior of an emergency vehicle 300.

It should be noted, however, that any desired size of strip LED light

sources 308 may be selected by an individual for use in association with the exterior of the emergency vehicle 300 including the use of a series of solitary light sources 306.

Referring to FIG. 35, a panel 304 of individual LED light sources 306 is depicted. The panel 304 may form the illumination element for the strip of LED light sources 308 and/or light bar 70 or light support 12, 302 as affixed to an emergency vehicle 300. Each panel 304 preferably contains a plurality of rows 34 and columns 32, 328 of individual LED light sources 306. The panels 304 are preferably in electrical communication with the controller 50 and power supply (now shown). The panels 304 preferably are controlled individually to create a desired warning light signal for an emergency vehicle 300 such as rotation, alternating, pulsating, sequencing, oscillation, modulated strobe, or flashing as preferred by an individual. Each panel 304 may be controlled as part of an overall warning light signal or pattern where individual panels 304 may be illuminated to provide the appearance of rotation and/or oscillation motion through the use of a modulated power intensity light source without the use of mechanical devices.

It should also be noted that the strip LED light sources 308 may be organized into distinct sections, segments, and/or sectors 326 for individual illumination by the controller 50. Each distinct segment, section, and/or sector 326 may therefore be illuminated with a visually different and distinct type of light signal with, or without, modulated or variable power intensity for the creation of a desired type of unique warning lighting effect for a vehicle. An infinite variety of color and/or pattern combinations or sequences may be established for the emergency vehicle 300 through the use of the controller 50.

Modulated power intensity may be regulated by the controller 50 to create the appearance of rotation or pulsation within a single panel 304, strip 308, or in conjunction with multiple separated or adjacent panels 304 or strips 308 for the provision of a composite warning light signal as desired by an individual. The warning light signal for each or a group of panels 304 or strips 308 may also be regulated by the controller 50 for the provision of a modulated power intensity for an observable warning light signal. All individual LED light sources 306 within a panel 304 or strip 308 may also be exposed to incrementally increased modulated power intensity to provide for an incremental increase in illumination for a warning light signal. The modulation of the

power intensity of LED light sources 306 within panel 304 or strips 308 thereby may provide the appearance of rotation of a light signal when observed by an individual. The power modulation or light intensity curve is anticipated to resemble a sine wave pattern when the warning light signal provides the appearance of rotation (Fig. 43). The power
5 to the individual light sources 306 may then be incrementally decreased at the preference of an individual. It should be noted that the power is not required to be terminated. It should also be noted that each individual LED light source 306 is not required to receive the same level of power output from the controller 50. Therefore different individual LED light sources 306 may receive different power output levels within a single warning
10 light signal. Individual LED light sources 306 within panel 304 are not required to be simultaneously and incrementally illuminated to provide for the appearance of rotation. It is anticipated that a pulsating and/or modulated variable light intensity may be provided by the controller 50 for regulation of the power output from thirty percent to maximum and back to thirty percent which affords a desirable type of pulsating
15 modulated variable light effect.

The provision of a modulated power intensity to the panels 304 may also be coupled with or in combination to the sequential illumination of columns 328 as earlier described. In this situation, the warning light signal may initially be dim or off as the individual columns 328 are sequentially illuminated and extinguished for
20 illumination of an adjacent column or columns 328. The power intensity for the illuminated column or columns 328 may simultaneously be incrementally increased for a combination unique rotational and pulsating modulated light signal. In addition, the controller 50 may be programmed to provide the appearance of rotation pulsation and/or oscillation at the discretion of an individual.

25 It should be noted that the provision of a modulated light or power intensity may be implemented in association with a light bar or light support 302, a cylindrical panel, a strip of lights 308, flat panels 304, or any other type of light source as desired by an individual for use with an emergency vehicle 300.

Referring to FIGS. 48 and 49, an individual LED light source 306 is
30 depicted in detail. The LED light source 306 preferably include a ceramic and/or heat resistant base 334. Centrally within the ceramic and heat-resistant base 334 is positioned a light source 336. The light source 336 is preferably enclosed within a protective cover

338. Extending outwardly from the individual light source 306 are a pair of contact paddles 340 which preferably provide for the electrical contacts for illumination of the light sources 336 during use of the individual light sources 306. The back of the LED light source 306 includes a slug 342. The slug 342 is designed to be positioned within
5 circular openings 344 of a circuit board or LED mounting surface 346 (FIG. 36). The circuit board or LED mounting surface 346 preferably establishes a heat sink within an aluminum base or frame 348 as depicted in FIGS. 38 and 39. The LED light sources 306 as depicted in FIGS. 48 and 49 preferably provide for a light intensity varying between 20 and 200 lumens or higher at the discretion of an individual. The positioning of the
10 slug 342 in the circular openings 344 of the circuit board or LED mounting surface 346 also preferably establishes a heat sink. A heat sink is desirable because the individual LED light sources 306 may have a sufficient level of power output during use to develop heat. As a result, the slugs 342 are positioned within the circular opening 344 and may be fully engaged to an adhesive for affixation to an aluminum base 349 (FIG. 38 and 39).
15 This combination assists in the dissipation of heat during use of the individual LED light sources 306 enhancing the performance of the light support 302.

As may be seen in FIGS. 31, 32, 37 and 50, in an alternative embodiment, the light bar or light support 302 or panel 304 may be formed of a single row of LED light sources 306. Within this embodiment, the LED light sources 306 are positioned
20 within circular openings 344 of circuit board or LED mounting surface 346 (FIG. 37). Circuit board 346 may be affixed to aluminum base 348 through the use of adhesive including glass beads where the circular openings 344 preferably establish a heat sink for the individual LED light sources 306. The use of adhesive including glass beads to affix the LED light sources 306 and circuit board 346 to the aluminum base 348 preferably
25 assists in the creation of electrical contact for the light bar or light support 302.

As depicted in FIG. 37 the top surface of the circuit board or LED mounting surface 346 may include two reflectors or mirrors 350. The reflectors or mirrors 350 are preferably elongate and are positioned substantially parallel to each other and are adjacent or aligned to the rows of individual LED's 306. The reflectors or
30 mirrors 350 preferably diverge upwardly and outwardly from a position proximate to the LED light source 306 and aluminum base 348. As such, the mirrors 350 have a separation distance which is narrow proximate to the LED light sources 306, where the

separation distance becomes larger as the distance vertically from the aluminum base 348 increases.

As earlier described, the brightest or most intense light of the individual LED light sources 306 is provided at an acute angle of approximately 40° to 42°. The reflector or mirror 350 as angled upwardly and outwardly relative to the row of LED light sources 306 reflects light exiting the LED light sources 306 along a desired line of sight which corresponds to perpendicular observation by an individual. The reflectors or mirrors 350 maximize the efficiency of the light sources 306 by reflecting light along the line of sight to be observed by an individual during an emergency situation. The reflectors or mirrors 350 may have a polished or non-polished surface at the preference of an individual depending on the brightness desired for the light support 302. The reflectors or mirrors 350 may also include one or more reflective sections 374 and/or transparent or clear sections 372. The transparent or clear sections 372 and the reflective sections 374 are described in detail with reference to FIGS. 27-30 herein. It should be noted that the surface of the reflectors or mirrors 350 may include any desired combination of sections, patterns, stripes, rows, and/or columns of clear or transparent sections 372 and/or reflective sections 374 as desired by an individual for a reflection of light illuminated from the individual LED light sources 306 during the provision of a warning light signal.

Wires 354 preferably connect the circuit board 346 to the power supply and controller 50. A modulated power source as earlier described may thereby be provided to the light support 302 which includes the reflector or mirrors 350. In this embodiment, the sequential illumination of individual LED's 306 may occur to provide a desired type of warning light signal. Also, the circuit board 346 as engaged to the base 348 may be separated into segments 326 of LED light sources 306 for use in combination with a modulated power intensity electrical source.

As depicted in FIGS. 38 and 39, the frame 348 includes a base 349. The base 349 may include a holding cavity 358. In the holding cavity 358 is preferably positioned a circuit board or LED mounting surface 360 which includes a plurality of circular openings 344. In each circular opening 344, is preferably positioned an individual LED light source 306. Above the holding cavity 358 is preferably a first support 362 and a second support 363. The first support 362 and second support 363

preferably have an angled interior edge 364. Each angled interior edge 364 is preferably adapted to receive a reflector or mirror 350. Each mirror 350 is preferably utilized to reflect light illuminated from an individual light source 306 along a visual line of sight as depicted by arrow AA of FIG. 39. The first and second supports 362, 363 also
5 preferably include a positioning ledge or notch 366 which is adapted to receive a glass or transparent plastic cover lens 368 which serves as a protector for the frame 348 and individual LED light sources 306.

Referring to FIG. 50, the frame 348 may be elongate having a first end 380 and a second end (not shown). The first end 380 and the second end preferably each
10 include an affixation area 382 which may be threaded for receiving engagement to a fastener 384 as preferred by an individual. A bracket 386 may be rotatably engaged to the first end 380 and second end at the preference of an individual by tightening of the fasteners 384 relative to the affixation areas 382. The bracket 386 preferably includes and angled portion 388 which may include a second fastener 390 which may include
15 suction cups. Alternatively, the second fastener 390 may be screws, bolts, and/or rivets for attachment of the frame 348 at a desired location relative to the interior or exterior of a vehicle 300.

Referring to FIGS. 26-30, a reflector or cullminator for the individual LED light sources 306 is disclosed. The reflector or cullminator is indicated in general
20 by the numeral 370. The reflector or cullminator 370 may be conical in shape and may be configured to encircle an individual LED light source 306. The reflector or cullminator 370 may be partially transparent. The reflectors 370 may have a clear section 372 and a reflective section 374. In FIG. 29, the clear section 372 is preferably positioned proximate to the LED light source 306 and the reflective section 374 is
25 preferably positioned to the top of the reflector 370.

In FIG. 28, the reflective section 374 is preferably positioned proximate to the LED light source 306 and the clear section 372 is preferably positioned to the top of reflector or cullminator 370. As may be seen in FIG. 30, the entire interior surface of the reflector or cullminator 370 may be formed of a reflective section 374. It should be
30 noted that any combination of clear sections 372 and reflective sections 374 may be utilized at the discretion of an individual. It should be noted that a plurality of clear sections 374 may be utilized within each reflector or cullminator 370 at the discretion of

an individual.

The use of a combination of clear sections 372 and reflective sections 374 enable an individual to select a configuration for the provision of partial illumination along an angle which is not parallel to a desired line of sight. An individual may thereby
5 be able to observe an illuminated light signal from the side or top of a light bar or light support 302 as opposed to being aligned with a desired line of sight.

Each of the cullminator or reflector cup 370 preferably includes an angled interior surface which extends upwardly and diverges outwardly from a central opening 394. Each central opening 394 is preferably constructed and adapted for positioning
10 approximate to and over an LED light source 306. Each of the cullminator or reflector cups 370 also preferably includes an angled exterior surface which extends upwardly and diverges outwardly from a bottom or base which is preferably positioned approximate to an LED mounting surface or circuit board 346.

Referring to FIG. 26 an array of cullminator cups or reflectors 270 may be
15 formed into a cullminator assembly or array 392. The cullminator assembly or array 392 is preferably adapted for positioning over an array of LED light sources 306. Examples of arrays of LED light sources 306 which may be utilized with a cullminator assembly 392 are depicted in FIGS. 3-10, 12, 14, 15, 23-25, 31, 32, 34, 35, 37, 39, 40, 44, and 47.

Each cullminator array 392 is preferably formed of a reflective material
20 which has plurality of reflective cups 370 disposed there through. Each opening 394 is adapted for positioning over an LED light source 306. The cullminator array 392 preferably has a sufficient thickness to establish an interior reflective surface having a sufficient dimension to reflect light as emitted from the LED light sources 306.

Alternatively, the interior surface of each reflector cup 370 may be entirely or partially
25 coated with reflective material at the discretion of an individual. It should be noted that the entire cullminator assembly 392 is not required to be formed of reflective material if the interior surface of the reflector cups 370 are coated with reflective material.

The cullminator array 392 may be formed in any shape as desired by an individual including but not necessarily limited to square, rectangular, triangular, linear,
30 circular, oval, and special or other irregular shapes for use in reflecting light emitted from an LED light source 306. The interior surface of any desired number of cullminator cups 370 may also be coated with reflective 374 and non-reflective 372 sections as earlier

described.

It should be noted that the strip LED light source 308 and LED light sources 306 in frame 348 are preferably designed to operate on a 12 volt power supply which is available in a standard emergency vehicle battery. It should also be noted that the frame 348 and strip LED light source 308 are preferably enclosed in a waterproof protector to minimize the risk of contamination or failure from any exposure to moisture or dust or dirt. The use of the strip LED light sources 308 and frame 348 preferably minimize the necessity to modify the exterior of an emergency vehicle 300 through the placement of holes or other apertures. In these embodiments, the wires 354 and 316 may be adhesively secured to the exterior of a vehicle for entry into the power source and controller 50 at a common location.

It should be noted that the strip LED light source 308 may be used on other devices and are not necessarily limited to use on an emergency vehicle 300. It is anticipated that the strip LED light sources 308 may be used on a variety of apparatus including but not limited to snowmobiles, water craft, helmets, airplanes, or any other device which may accept use of an LED light source.

In FIGS. 40 - 43 a warning signal light 400 is depicted which in general includes a light source 402 and a rotatable reflector 404. The light source 402 may include one or more individual LED illumination devices 406. The light source 402 may include a base 408 which may be mounted on a post 410. The light source 402 may either be stationary or rotate at the preference of an individual.

A motor 412 is preferably electrically connected to a power supply for rotation of a wheel or gear 414. The wheel or gear 414 is connected to the motor 412 by a shaft 416. The wheel or gear 414 is in contact with, or is engaged to, a rotatable collar 418 which may be adapted to rotate freely about the post 410 during operation of the motor 412. The wheel or gear 414 may be formed of rubber material or any other desired material as preferred by an individual. Alternatively, the wheel 414 may include teeth and function as a gear for engagement to corresponding grooves and teeth as integral to the exterior surface of the collar 418.

An aperture 420 may pass through post 410 to receive wires 422 for the provision of power to LED light source 402. A washer or support device 424 vertically supports rotatable collar 418 on post 410 from a position below collar 418. A positioner

426 functions to restrict the vertical movement of the collar 418 upwardly during engagement of the motor 412 and rotation of the wheel 414 and collar 418.

A horizontal support arm 428 extends outwardly from collar 418. A vertical support arm 430 extends upwardly from horizontal support arm 428. Angular support arm 432 extends inwardly and upwardly from vertical support arm 430 for positioning of a reflector or mirror 434 above light source 402. The reflector or mirror 434 is preferably positioned at an approximate angle of forty-five degrees relative to the light source 402. Light as emitted vertically from the light source 402 may then reflect from the reflector 434 along a substantially perpendicular line of visual sight. The reflector 434 rotated ninety degrees is depicted in phantom line as an oval due to the angular offset of approximately forty-five degrees.

The use of motor 412 rotates wheel 414 which in turn rotates collar 418 and reflector 434 in a circular direction about light source 402 for the provision of an observed rotational warning light source. In addition, the light source 402 may be electrically coupled to a controller 50 to provide a modulated, alternating, variable, pulsating, or oscillating light source at the preference of an individual simultaneously to the rotation of the reflector 434 about light source 402.

Referring to FIG. 41 the warning signal light 400 includes a light source 402 which is rotatable in conjunction with the reflector 434. In this embodiment the motor 412 is connected to a first gear which is enclosed within casing 436. A second gear is also enclosed within casing 436 and is coupled to the first gear for rotation of the reflector 434. A vertical rod 438 is preferably affixed or integral to the second gear. The vertical rod 438 supports the LED light source 402 as positioned adjacent to reflector 434. An angled brace 440 is also preferably engaged to rod 438. Angled brace 440 supports reflector 434 during rotation of reflector 434 which represents a circular motion as depicted by arrow 442. In this embodiment reflector 434 is arcuate in shape and may be parabolic at the discretion of an individual. Light emitted from light source 402 may then be reflected by the arcuate reflector 434 along a desired line of sight. The engagement of the motor 412 rotates the light source 402 and reflector 434 to provide a rotational light source as observed by an individual. It should also be noted that the light source 402 may be coupled to a controller 50 to provide for a modulated, alternating variable, and/or pulsating light signal in conjunction with the rotation of the reflector

434.

Referring to FIG. 42, the reflector 434 is not required to be flat and may include a convex or concave face 444. The provision of a convex or concave face 444, is utilized to assist in the creation of a unique variable light effect as observed by an individual. Light as emitted from the light source 402 may then be reflected at any desired angle other than perpendicular for observation by an individual. The pulsating intensity of the light as observed by an individual may then be unique, especially when used in conjunction with the rotated reflector 434 and variable or modulated power intensity from the controller 50. In addition, the use of a convex or concave reflector 444 may expand or enhance the observation of the warning signal light 400 by individuals beyond a perpendicular line of sight. The warning signal light 400 may then be observed above or below a light source 402. The reflector 434 as rotated ninety degrees is depicted in phantom line and is generally oblong or oval in shape.

FIG. 43 represents graphically the variable or pulsating illumination of the observed light as reflected from the reflector 434 of fig. 42. Time is represented along the x-axis and increasing brightness is depicted along the y-axis. The graph of FIG. 43 shows the gradual increase in brightness of the observed light as the reflector 434 is rotated to a maximum illumination corresponding to direct in line observation of the warning light signal and then the gradual decrease in observed light intensity as the reflector 434 is rotated away from direct in line sight. It should be noted that the observed warning light signal is not required to be extinguished and may be reduced to a minimum observable intensity of approximately thirty percent.

Referring to FIG. 44, the warning signal light 400 in general includes a light source 402 which may be rotated through the use of a motor 412 for transmission of light through a filter 446 for reflection from a conical reflector 448 as mounted to the interior of a light bar or light support 450.

Power for motor 412 is supplied through wires 452 from a power source not shown. Power for the light sources 402 is provided through wires 454 in support 456. Brushes 458 may be in electrical communication with the power from the wires 454 to transmit electrical current to a second set of brushes 460 utilized to communicate power to the light sources 402. The base 462 of the light source 402 may preferably be formed of an electrically conductive material to facilitate the provision of power to the

light sources 402.

A shaft 464 preferably extends between the motor 412 and the base 462 where operation of the motor 412 rotates the shaft 464 and the base 462 having the light sources 402. Light is transmitted vertically upward from the light sources 402 through the filter 446. (FIGS. 44 and 45.) The filter 446 may include one or more sections of tinted material 466. The filter 446 may be stationary or may be rotatable at the discretion of an individual. The tinted material 466 may be any color as desired by an individual or opaque to establish a desired illumination effect for an emergency warning signal light. Any number of tinted sections 466 or transparent areas may be placed on the filter 446.

10 The filter 446 may be formed of glass or plastic or other sturdy material at the preference of an individual. The tinted sections 466 may be integral to or placed upon the filter 446 as desired. The filter 446 may be attached to the conical reflector 448 by a fastener 468.

The conical reflector 448 preferably includes a straight reflective edge

15 470. Alternatively, the reflective edge 470 may be concave or convex as desired by an individual to establish a unique lighting effect. The conical reflector 448 is preferably affixed to and descends from the top of a light bar or light support 450 as may be attached to an emergency vehicle 300.

Light transmitted upwardly from the light sources 402 passes through

20 either a substantially transparent section or through the tinted or opaque material 466 which may block light transmission or alter the color of the light as desired. Light is then reflected from the conical reflector 448 at a desired angle for transmission through the vertical sections of the light bar or light support 450 for observation by an individual.

FIG. 46 represents graphically the intensity of the observed light as

25 reflected from the conical reflector 448 of FIG. 44. Time is represented along the x-axis and observed brightness is represented along the y-axis. The observed light signal transmitted from the warning signal light of FIG. 44 is much steeper which corresponds to a shorter period of observation more similar to a flashing light signal. It should be noted that the light sources may also be coupled to a controller 50 for the provision of a

30 variable, modulated and/or pulsating light effect.

Referring to FIGS. 31 and 32 a modular light support 480 in general includes an LED mounting surface 482 having one or more LED light sources 306, a

cullminator assembly 484 and a cover 324.

The LED mounting surface 482 is preferably elongate and includes a plurality of LED light sources 306. In general, one to five LED light sources 306 are disposed in a linear orientation along the LED mounting surface 482 which may be a circuit board as earlier described. The LED mounting surface 482 also preferably includes a first end 486 and a second end 488. An opening 490 is preferably positioned through the LED mounting surface 482 proximate to each of the first end 486 and second end 488.

The cullminator assembly 484 preferably includes a plurality of reflector cup areas 492. The cullminator assembly 484 preferably includes a plurality of support walls 494 and a top surface 496. The cullminator assembly 484 preferably includes a plurality of openings 490. Each of the openings 490 is preferably sized to receivingly position and hold the individual LED light source 306 during assembly of the modular light support 480. The reflector cup areas 492 are preferably equally spaced along the cullminator 484 to correspond to the spacing between the individual light sources 306 as disposed on the LED mounting surface 482.

The cover 324 is preferably transparent permitting transmission of light emitted from the LED light supports 306 therethrough. The cover 324 preferably includes a forward face 498, a pair of end faces 500, a top face 502 and a bottom face 504. Each of the pair of end faces 500 preferably includes a receiving notch 506 which is adapted to receivingly engage the LED light mounting surface 482 during assembly of the modular light support 480. An affixation opening 508 preferably traverses the forward face 498 proximate to each of the pair of end faces 500. A fastener 510 preferably passes through the affixation opening 508 for engagement to the opening 490 to secure the LED mounting surface 482 into the receiving notch 506. It should be noted that the cullminator assembly 484 is then positioned within the interior of the cover 324 where the top surface 496 is proximate to the forward face 498. The illumination of the LED light sources 306 then transmits light through the forward face 498 for observation of an emergency warning light signal.

Specifically referring to FIG. 32 one or more modular light support 480 may be positioned adjacent to each other for the creation of a light bar or light stick 512. The modular light supports 480 and/or light bar or light stick 512 may be coupled to a

controller 50 which may independently and/or in combination provide a plurality of independent and visually distinct warning light signals as earlier described. In addition, the controller 50 may provide modulated and/or variable power intensity to the individual LED light sources 306 to establish unique warning light signal effects. It should also be noted that the controller 50 may individually illuminate LED light sources 306 to provide for one or a combination of colored light signals as desired by an individual.

Any number of modular light supports 480 may be positioned adjacent to each other to comprise a light bar or light stick 512 at the preference of an individual. It should be further noted that a plurality of modular light supports 480 may be positioned at any location about the exterior or within the interior of a vehicle at the discretion of an individual. In one embodiment each of the individual modular light supports 480 will be electrically coupled to a power supply and controller for the provision of unique individual and visually distinctive warning light signals and combination warning light signals as earlier described

Referring to FIG. 47 and alternative embodiment of a reflector assembly is disclosed. In general, the reflector assembly of figure 47 includes an enclosure 518. Positioned within the interior of enclosed 518 is preferably a motor 520 having a shaft 522 and a gear 524. A first support 526 preferably has a periphery having a plurality of teeth 528 adapted to releasably engage the gear 524. The first support 526 preferably includes a mirror bridge 530 which is preferably used to position a mirror 532 and a proximate angle of 45° relative to a LED light source 306. Preferably within the interior of the first support 526 is located a cullminator assembly 534 which may include one or more reflective cups as earlier described. Individual LED light sources 306 are preferably positioned within each of the cullminator cups of the cullminator assembly 534 to maximize the direction of emitted light for reflection from the mirror 542.

On the opposite side of gear 524 is located second support 536. Second support 536 also includes a periphery having a plurality of teeth 528, a mirror bridge 530, a mirror 532, and a cullminator assembly 534 disposed adjacent to a plurality of individual LED light sources 306.

A third support 538 is preferably adjacent to the second support 536. The third support 538 also preferably includes a periphery having a plurality of teeth 528, a mirror bridge 530, and a mirror 532 disposed at a 45° angle above a cullminator

assembly 534. A plurality of individual LED light sources 306 are preferably disposed within the reflector cups of the cullminator assembly 534. It should be noted that the teeth 528 of the third support 538 and second support 536 are preferably coupled so that rotational motion provided to the second support 536 by the gear 524 is transferred into rotational motion of the third support 538.

In operation, the individual LED light sources 306 are preferably connected to a power source and/or a controller 50 as earlier described. The controller 50 may provide for any type of unique lighting effect including modulated or variable power intensity as earlier described. An infinite number of independent visually distinctive warning light signals may be provided for the rotational reflector as depicted in 487. It should also be noted that an infinite number of warning light signal combinations may also be provided by the controller 50 for use with the rotational reflector of FIG. 47.

Each of the mirrors 542 may be positioned for reflection and transmission of light to a desired field of vision relative to the rotational reflector. A flashing and/or rotational light source may be provided for observation by an individual.

It should be noted that the first support 526, second support 546, and third support 538 may be synchronized to provide for a unique warning signal light for observation by an individual. It should be further noted that the engagement of the motor 520 for rotation of the gear 524 simultaneously rotates the first support 526, second support 536 and third support 538 for the provision of a warning light signal.

LED technology enables the selection of a desired wave length for transmission of light energy from the individual LED light sources 306. Any wave length of visible or non-visible light is available for transmission from the LED light sources 306. As such, generally no filters are required for use with individual LED light sources 306. The individual LED light sources 306 may be selected to provide for any desired color normally associated with the use in emergency vehicles such as amber, red, yellow, blue, green and/or white.

It should be further noted that the controller 50 may simultaneously display any number of combinations of warning light signals. For example, the controller 50 may provide for a solitary light signal for transmission from a light source. Alternatively, the controller 50 may effect the transmission of two signals simultaneously

from the identical light source where a first warning light signal is emitted from one portion of the light source and a second warning light signal is emitted from a second portion of the light source. Alternatively, the controller 50 may alternate the two warning light signals where the first area of the light source first transmits a first warning light signal and secondly transmits a second warning light signal. The second area of the light source initially transmits the second warning light signal and then transmits the first warning light signal. Further, the controller may transmit two independent and visually distinct warning light signals simultaneously within different areas of light source. The controller 50 may also reverse the warning light signals for simultaneous transmission between different areas of the light source. Further, the controller 50 may regulate the transmission of more than two visually distinct types of warning light signals from a light source at any given moment. The controller 50 may alternate warning light signals within different areas or enable transmission of warning light signals in reverse alternating order for the creation of an infinite variety of patterns of visually distinct warning light signals for use within an emergency situation. The controller 50 may also permit the transmission of a repetitive pattern of warning light signals or a random pattern of visually distinct warning light signals at the preference of an individual.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof; and it is, therefore, desired that the present embodiment be considered in all respects as illustrative and not restrictive, reference being made to the appended claims rather than to the foregoing description to indicate the scope of the invention.